Lessons Learned: Joint Battlespace Dynamic Deconfliction (JBD2) Distributed Test Event

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***Abstract*—This paper presents the lessoned learned from the Joint Battlespace Dynamic Deconfliction (JBD2) test conducted in August 2008. The lessons learned presented are those collected by the Test Integration Working Group (TIWG). The JBD2 test event was executed in a Joint environment across 16 different test sites with live, virtual, and constructive elements connected through the Joint Mission Environment Test Capability (JMETC) Virtual Private Network (VPN). All Wide Area Network (WAN) simulation traffic was exchanged using the Testing and Training Enabling Architecture (TENA).**

Keywords: Distributed Testing, Live Virtual and Constructive (LVC), Test Control, Modeling & Simulation

I. OVERVEIW OF JBD2

DoD Strategic Planning Guidance demanded the creation of a Joint environment testing capability. This demand led to the creation of the Joint Test and Evaluation Methodology (JTEM) project and Joint Mission Environment Test Capability (JMETC) as part of the larger testing in a Joint environment initiative. Concurrently, the Combined Test Organization (CTO) for Future Combat Systems (FCS) recognized that testing systems to meet Joint Mission Environment (JME) requirements presents new challenges that require new test capabilities. As the FCS testing strategy matured, along with JTEM and JMETC, a mutually beneficial relationship was realized and evolved into the Joint Battlespace Dynamic Deconfliction (JBD2) to provide the following key benefits:

- For JTEM, JBD2 serves as a Joint capability "use case" in order to evaluate the effectiveness and suitability of the Capability Test Methodology (CTM) methods and processes (M&P) for designing and executing tests of System of Systems (SoS) in the JME, utilizing the CTM v2.0.
- For FCS CTO, JBD2 will establish a rigorous test context to examine FCS test technology capabilities needed for testing in a JME in support of FCS Milestone (MS) C test activities.
- For JMETC, JBD2 will mature the baseline capability to support SoS level testing across the Joint Services and characterize the network infrastructure.

The JBD2 test event provided a high fidelity, real-time, rapidly configurable, distributed network including virtual and constructive models linked with live systems. The purpose of the environment is to evaluate command and control (C2) for Joint Fires (JFIRES) and Joint Close Air Support (JCAS) as well as support the development and testing initiatives for the partnered organizations. The JBD2 test was executed August 4-7, 2008.

A. Roles of the Working Groups

There are many functions and duties required in the design and implementation of an operationally-relevant Live, Virtual, and Constructive (LVC) test environment. For JBD2 these duties along with the test execution and data analysis functions were divided between four working groups:

- Operational Capabilities Working Group (OCWG) - Define tactically relevant scenarios for JBD2 Joint Operational Context for Test (JOC-T) and ensure created test environment is operationally relevant
- Joint Mission Environment Design Working Group (JDWG) – Develop the JBD2 Logical Design, Physical Design, and System Description Document (SDD)
- Test Integration Working Group (TIWG) – Responsible for network infrastructure, implementation of Physical Design, integration of systems, and execution of test
- Test Design and Analysis Working Group (TDAWG) – Develop overall test design, ensure required data is collected, and perform analysis of test results

This paper will focus on the roles and responsibilities of the Test Integration Working Group and will present lessons learned from the TIWG perspective. The overview in this paper is intended to provide enough information about JBD2 to put the TIWG lessons learned in context. However, it is not a complete summary of the JBD2 test event.

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1) *TIWG Overview*

The TWIG was a small technically focused group responsible for test integration, test execution, network infrastructure, and network security. The TIWG selected and distributed all test execution tools necessary for the conduct of the JBD2 test. Integration of the JME was conducted through integration spiral events coordinated by the TIWG through the Integration Spiral Plan. Test integration activities were done in accordance with the Physical Design Documents and the Detailed Test Plan. All details of the test integration process were documented in spiral reports completed at the end of each spiral. During the dry run week and test week, situation reports were generated and distributed on a daily basis. The TIWG process follows the hierarchal design presented in Fig. 1.

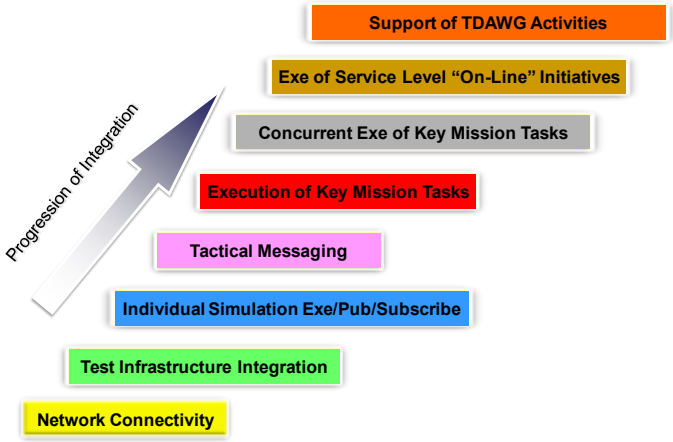

Figure 1. Integration Waterfall Diagram

B. *SYSTEM DESCRIPTION*

To support the JBD2 test event a notional SoS was assembled to provide the capability to deconflict near-real-time tactical changes during the full range of military operations.

Airspace control procedures provide maximum flexibility through an effective mix of positive and procedural control measures. The control structure encourages close coordination between components to allow rapid concentration of combat power. The methods of airspace control vary throughout the range of military operations. They range from positive control of all air assets in an airspace control area to procedural control of all such assets, or any effective combination of the two. Airspace control procedures and systems need to accommodate these methods based on component, Joint and national capabilities, and requirements.

II. TEST CONCEPT

The following sections describe the overall goal and test objective of the JBD2 test event. The test design provides the test factors and their respective levels as well as the potential test execution matrices. Additionally, an overview of the test scenario and the specific mission tasks of interest which provide operational context for the test are included. The test concept section concludes with the live, virtual, constructive distributed environment LVC-DE design and a description of the test venue.

The overall objective of the JBD2 Test Event is to assess the degree the blue force can successfully conduct identified missions in the context of controlled changes to specific materiel and non-materiel factors, holding other factors constant. The two battlespace management systems are the Theater Battle Management Core Systems (TBMCS) and Tactical Airspace Integration System (TAIS).

TBMCS provides the combat air forces and the Joint/combined forces with an automated and integrated capability to plan and execute the air battle plan for operations and intelligence personnel at the combined air operations center and individual unit levels. It provides the air commander with the means to plan, direct, and control all theater air operations in support of command objectives. It also coordinates with engaged ground and maritime elements.

TAIS is the Army's materiel solution for the integration and synchronization of Airspace Command and Control (AC2) and en route Air Traffic Services (ATS) within the Army Battle Command System (ABCS).

A. *Test Design*

This SoS is a C2 capability which will analyze two factors. The first factor will be the battlespace management capability (current – TBMCS/TAIS 9.3 versus future – TBMCS/TAIS 10.0). The second factor is the C2 processes utilized by the Joint forces (current procedural-based processes versus future "expedited" processes). Each of these factors is comprised of two levels (current level and future level).

Battle Space Management

The materiel test factor attempts to discern if a difference exists between the current and future SoS being implemented:

- Current: implementation with TBMCS and TAIS 9.3
- Future: implementation with TBMCS and TAIS 10.0

Timeliness of C2 processes

The non-materiel factor focuses on differences in the C2 processes as either the current procedural-based process versus a future process.

- Current: procedural based process
- Future: "expedited" based process

Factors and Levels Combinations

Each of the four combinations of factor levels is a trial. Each conduct of a trial is a run. Table I shows the factors, levels, and associated notations.

TABLE I. EXPERIMENTAL FACTORS, LEVELS, AND NOTATION

Trial	Factor 1 Battlespace Management	Factor 2 Timeliness of C2 Processes	Run 1	Run 2
1	Current TAIS 9.3	Current procedural	$[C,C]_1$	$[C,C]_2$
2	Current TAIS 9.3	Future expedited	$[C,F]_1$	$[C,F]_2$
3	Future TAIS 10.0	Current procedural	$[F,C]_1$	$[F,C]_2$
4	Future TAIS 10.0	Future expedited	$[F,F]_1$	$[F,F]_2$

B. *Operational Context*

The JBD2 test event is focused on six key mission tasks as listed in Table II and is further categorized by the mission type. During the test event, these key mission tasks occur simultaneously and/or sequentially as the scenario executes according to the master scenario event list (MESL).

TABLE II. KEY MISSION TASKS

Type	Mission Task
Joint Fires (JFIRES)	US Army (USA) Maneuver (MVR) Observer to US Marine Corps (USMC) High Mobility Artillery Rocket System (HIMARS)
	US Marine Corps (USMC) Maneuver (MVR) Observer to US Army (USA) Non-Line of Sight - Launch System (NLOS-LS)
	US Air Force (USAF) Unmanned Aerial Sensor (UAS) to US Army (USA) Non-Line of Sight - Launch System (NLOS-LS)
	US Air Force (USAF) Unmanned Aerial Sensor (UAS)/ US Army (USA) Forward Support Element (FSE) to USAF Weaponized UAS (w/SWARM)
Joint Close Air Support (JCAS)	US Air Force (USAF) Joint Terminal Attack Controller (JTAC) to US Air Force (USAF) Fixed Wing
	US Marine Corps (USMC) Joint Terminal Attack Controller (JTAC) to Fixed Wing (US Air Force (USAF) / US Navy (USN))

Fig. 2 shows the JBD2 Operational View 1 (OV -1) with each of the six Key Mission Tasks represented with the major sensors, weapons, and C2 systems.

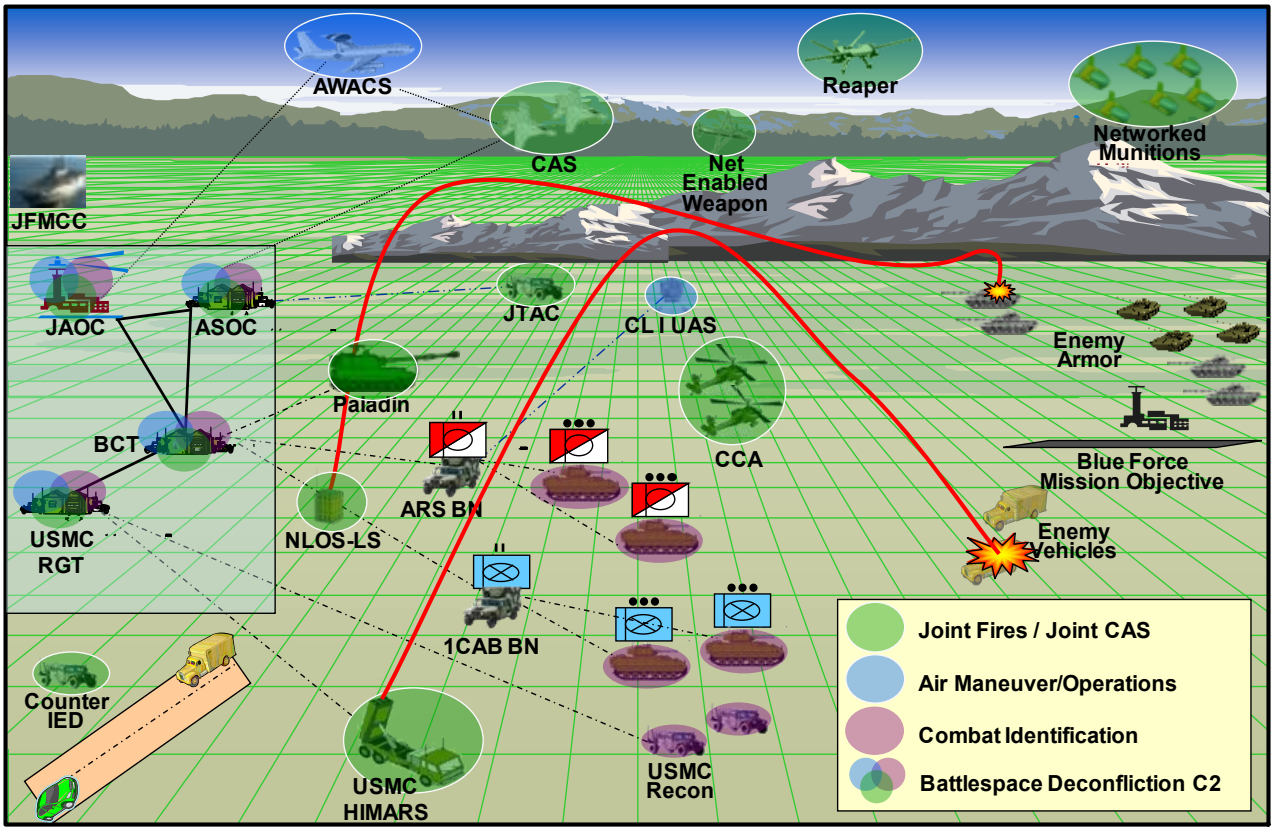

Figure 2. JBD2 Operational View 1 (OV-1)

C. *Live Virtual Constructive – Distributed Environment (LVC-DE) Design*

The JBD2 test event was executed in a Joint environment across 16 different test sites with live, virtual, and constructive elements connected through the JMETC VPN. All Wide Area Network (WAN) simulation traffic was exchanged using the Testing and Training Enabling Architecture (TENA). Each system involved in the test was time synchronized to local NTP servers or GPS. The JBD2 test event terrain is a 4 X 3 degree region in the area of Fort Bliss, Texas, and White Sands Missile Range (WSMR).

The tactical communication standards used in the LVC-DE included Tactical Digital Information Link (TADIL-J), Variable Message Format (VMF), and the United States Message Text Format (USMTF). The JBD2 infrastructure supported tactical communications across the test WAN.

The simulation architecture for JBD2 was driven by the simulations selected to participate, rather than the architecture driving which systems were selected. This approach resulted in a mixed simulation architecture using multiple simulation protocols including Distributed Interactive Simulation (DIS), the High Level Architecture (HLA), and the Test and Training Enabling Network Architecture (TENA).

A goal from the start of JBD2 test planning was to take full advantage of the JMETC infrastructure and tools in the design of the JBD2 simulation architecture. JMETC has selected TENA as the common simulation middleware for achieving Joint interoperability between DoD ranges. TENA was selected to be the only simulation protocol used across the WAN. JMETC gateways were used at each site that required DIS or HLA traffic on their LANs. Each lab using HLA simulations ran an isolated HLA Federation and Run-time Infrastructure Execution (RTIExec).

D. *Test Venue*

The venue for JBD2 test event is a distributed test event linking test facilities and sites in order to compose a LVC-DE. Each capability provider is linked using the JMETC infrastructure in order to compose the JME required for the test event. Fig. 3 provides an illustration of the test participants' organizations with their supporting roles and systems.

The JMETC Virtual Private Network (VPN) was established on the High Performance Computing Modernization Program Office – Secure Defense Research and Engineering Network (HPCMPO-SDREN). The JMETC VPN enabled use of JMETC System Control (SYSCON) tools for network quality

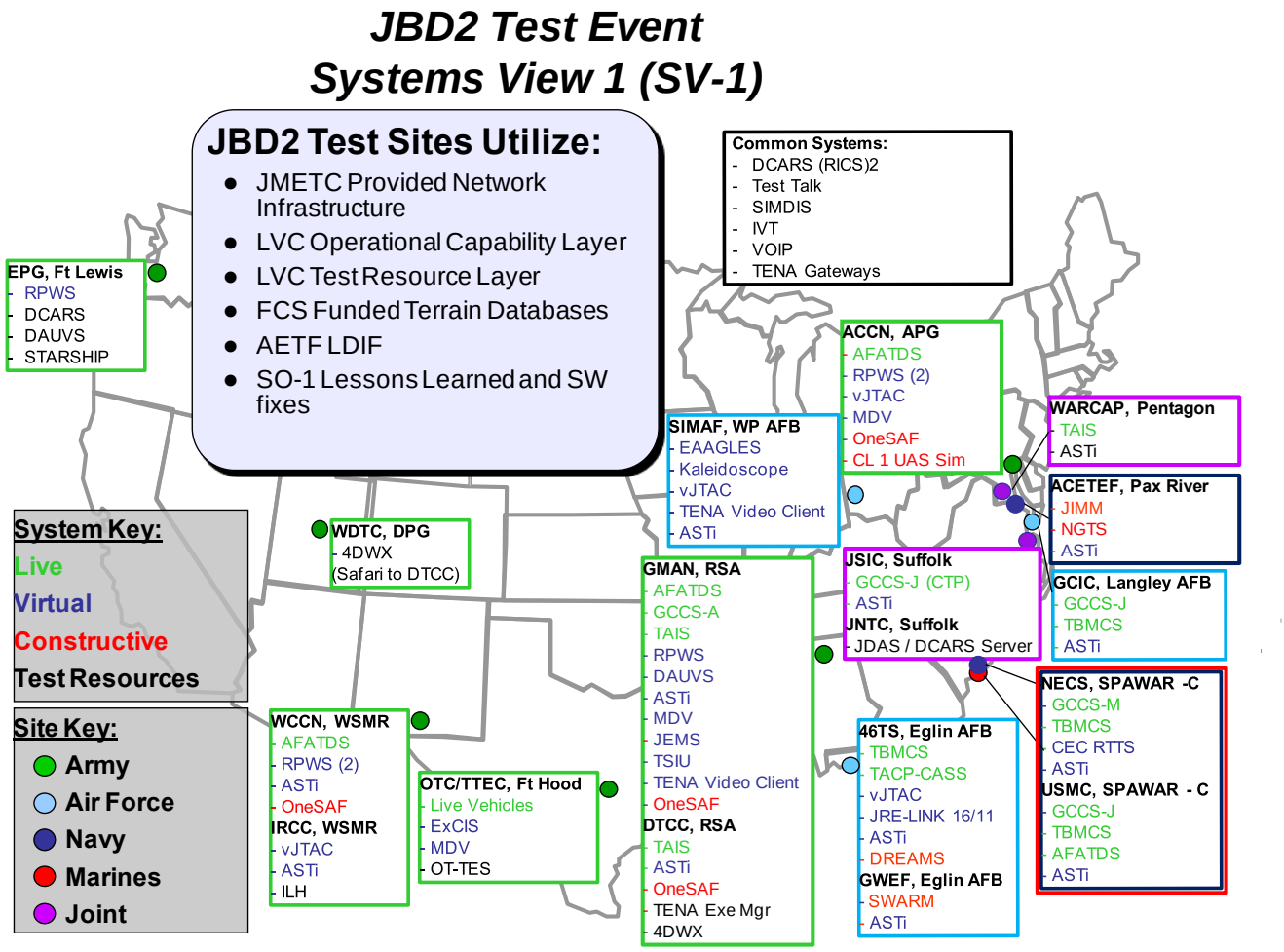

Figure 3. JBD2 System View 1 (SV-1)

control and supports effective use of other JMETC products. JMETC used the Network Aggregation Router to bridge to other secure networks, such as the Air Force Integrated Collaborative Environment (AF–ICE) and the Joint Training and Experimentation Network (JTEN). JDB2 required six new VPN sites with two of the sites connected via the Network Aggregation router.

- **JMETC VPN**
  - Redstone, RTTC DTTC
  - Redstone, RTTC GMAN
  - Pax River, ACETEF
  - White Sands, IRCC
  - Eglin AFB, GWEF
  - Eglin AFB, 46TS C2TF
  - JFCOM, JSIC
  - Aberdeen, ACCN
  - Ft. Hood, OTC-TTEC
  - Charleston SSC, Bldg. 3147
  - Charleston SSC, Bldg. 3440
  - Ft. Lewis, EPG
- **JTEN Enclave**
  - JFCOM, Test Bay 8
- **AF-ICE Enclave**
  - Wright Patterson AFB, SIMAF
  - Langley AFB, GCIC
  - Pentagon, WARCAP

III. LESSONS LEARNED

The lessons learned portion of this paper is divided into sections that correspond to different aspects of the integration and test process: Pre-Test/Integration, Test Sites and Network, Test Execution, and General. Recommendations for future events and investments are also included with the description of the lessons learned.

A. Pre-test/Integration

During the pre-test/integration phase of JBD2, several lessons were learned. First, it is recommended that site surveys/certification be conducted prior to selecting which sites will participate in the test. The site surveys should determine if the site:

- can support computers systems running both Linux and Windows operating systems.
- is approved for classified open storage. This is critical in a classified distributed test.
- will have enough personnel available during spiral integration and test runs (all sites should have a minimum of 2 people in the lab).
- has back-up personnel available for key positions being hosted at that site.
- has enough commercial and VoIP lines available in the lab. A site should have at least 2 VoIP phones and 2 commercial lines. These phones should be located next to key systems.
- has enough computers to run all required applications. Running multiple network-intensive or graphics intensive applications on a single computer should be avoided.

If a site is selected to participate in the event, performing on-site integration of required tools (protocol gateways, test tools, etc.) should be considered.

Additionally, during the pre-test phase, a complete list of required IP addresses, ports and protocols should be defined early in the process. During JBD2, the majority of network complaints and issues were related to undocumented ports and IP addresses. Not having the IP addresses, ports, and protocols defined by all sites early had a definite impact on the integration and dry run spirals.

Several applications were integrated very late in the JBD2 schedule with minimal integration testing and documentation. It is essential for new applications (or for significant changes to existing applications) be documented, tested, and validated before the integration spirals being. The lead range should support one-on-one testing as needed during early integration to help with application testing. All applications playing in a distributed event should have design documentation including enumeration data and this documentation should be provided to event organizers early in the process. It is important to note that development and testing of the protocol gateways cannot be completed until all application and enumeration data is submitted.

Multiple integration spirals are required to integrate a large multi-site distributed test event. The number and extent of the spirals is greatly dependant on the level of distributed test maturity at the participating sites, required interoperability between the sites, the number of new tactical applications, and the number of new test tools being integrated. Plans for these integration spirals should contain a detailed schedule of activities. However, sites must be flexible as planned activities may be shorter or longer than expected. Once the initial site integrations are complete, spirals in which all sites cannot fully participate have reduced value since full integration testing cannot be accomplished until all sites are online. Development of a "Test Harness" class of tool is needed to aid sites in certifying their ability to exchange data properly before entering integration.

During JBD2 multiple integration activities were performed simultaneously during a spiral. For concurrent activities to be effective, sites need several personnel and communication lines available. Each simultaneous activity needs its own lead. Additionally, an end-of-the-day "hot wash" should occur where all sites discuss their accomplishments.

It is also good practice to have a backup plan for all critical applications and sites. Although, this will increase integration activities and cost, it is essential during large distributed tests.

During the LVC-DE integration spirals, the inclusion of analytical requirements as part of the objective facilitated early utilization of the data collection process and identified data collection issues. The early involvement improves process familiarization, increases the speed of the data reduction, and directly supports the Verification & Validation (V&V) process.

B. Test Sites and Network

All test sites should have organic/local test network support. This support should allow each lab/range to quickly react to problems. If the site does not have network support available in the same building, the site must work with their network support organization to have someone on call and readily available. Several times during JBD2, the integration was delayed while awaiting network personnel to respond to a call. Often it was a simple operation that needed to be completed, but it would take several hours while awaiting network personnel to respond (often having to drive across the base to do so).

To the extent possible, participating sites should not have firewalls. Issues with firewalls consumed a significant amount of integration time. If firewalls cannot be avoided at a site, modifications to the firewall/access control list should be made by classes or ranges of IPs addresses, not by individual addresses or ports.

In a multi-architecture test environment gateways are a critical element. When using new gateway building tools, onsite support from the tool developer may be needed. Many gateway builder bugs were found during the JBD2 integration spirals. Unfortunately, due to the late integration of several applications and hence the late completion of the gateways, load testing (throughput, latency) was not completed on the gateways before the JBD2 event runs for record. It is recommended that remote control capabilities be added to the gateways for future events. This capability would allow personnel to more easily troubleshoot gateway problems at remote sites. Additionally, the network characterization and test tools should have the capability of remote operation. A quick look network performance/health tool would be a valuable asset to have during distributed tests.

A real-time TENA capable Cross Domain Solution (CDS) is needed between classified and unclassified test networks to allow visualizing tests and performing selected data analysis in an unclassified environment. Additionally, a test network design approach that will handle the tactical IP address space (non-routable addresses) must be developed.

The Joint test community must work with the various DoD Information Assurance (IA) departments to develop consistent service-level IA requirements, i.e., the IA requirements should be the same from service-to-service. It is difficult to share tools and applications if the IA and software certification requirements and language are not consistent. Additionally, a method for Security Classification Guide (SCG) development to support Joint distributed testing needs to be determined.

C. Test Execution

During the test event there were several tools that proved to be useful. Having a classified wiki (wiki is a type of website that allows users to add, remove, and edit the content) was very important for information sharing after the concept was embraced by all sites. The unclassified wiki was used more in the test planning and initial integration activities. White Sands Missile Range (WSMR) provided a persistent commercial conference phone line that was available for the whole event. The Distributed Capabilities Integration Toolbox (DCIT) was very useful for integrating such a large distributed event by providing a single place for sites to check-off important events as they were accomplished. The Digital Collection, Analysis, and Review System (DCARS) was useful for distributed data collection. The DCARS LAN Data Collector (LDC) data stream to the DCARS Data Processing Units (DPUs) was the largest source of data on the network. This was anticipated for JBD2 based on the data collection design but future test event designers should pay careful attention to the data collection/network architecture.

One test resource tool that was not made available during JBD2 was a test conductor chat capability. This would have been a very useful tool to augment other forms of communication (Voice, VTC, wiki, etc.). Another useful communication tool was the classified Video Teleconference (VTC) capability that existed between two of the test labs. Adding this capability to all sites would aid in communication if the network bandwidth is available. During test execution (spirals, dry runs, runs for record), it is recommended that one person be assigned to monitor the test control communication line at all times.

Before the start of every test, each site was required to follow a specific start-up sequence to ensure certain essential activities were performed. The TestTalk tool was used to display the official “run clock” for all sites and to display the site specific Time Ordered Event List (TOEL). This TOEL was what each site followed during the start-up sequence. This approach proved very beneficial in starting the complicated JME in a structured, repeatable manner.

At the end of the day, daily situation reports (SITREPS) were compiled and distributed to a large audience. This proved to be a very valuable way to distribute the daily progress of JBD2. However, there needs to be more granularity in the SITREPS. It is recommended that one be generated for the operators of the test and one generated for management (more high-level, less technical details.). Also, to expedite the compilation of the SITREPs, a procedure for data transfer across security domains is essential at the lead and/or data archival site.

D. General

Complicated operational scenarios with multifaceted tactical communications, such as the one used in JBD2, require more spiral integration events. Several spirals need to be devoted to working operational issues, and these spirals cannot be

performed until the technical integration is complete. More operator training is necessary if technical personnel are required to play an operational role or use operational equipment. It is recommended that at least one full spiral be devoted to this training.

Test sites need to consider and plan resources, such as space, hardware (computers, VoIP, radio), and software (web-based, data collection/reduction) to support observers and analyst efforts to evaluate the system under test. The use of chat rooms in battle command centers has become common place, but the ability to capture and analyze the data is lacking. Recommend the T&E community identify methods and process as well as applications to capture and analyze the information communicated by these technologies.

As technical maturity evolves, test programs utilizing tactical command and control infrastructure should use tactical network/communication simulations versus the "perfect" connections utilized in JBD2 test. The addition of the tactical network simulation is needed to provide realistic test scenarios for the network centric environment.

More problem correction time is needed between the integration spirals until the architectures, implementations, test sites, and processes mature. Test sites must develop a respect for the rigor of testing in a LVC distributed environment. Persistent networks, test infrastructure, and continual employee training are needed as well as periodic integration activities with other organizations to make LVC distributed testing executable in a realistic timeframe and budget.

IV. CONCLUSIONS

The JBD2 test event was a major leap forward in the test planning, test conduct, and evaluation of systems in a Joint distributed test environment. In all Joint testing, cultural challenges exist and JBD2 made significant progress in breaking down the barriers. JBD2 was a real test program with test factors and levels and a true factorial design.

With a persistent network and common test tools and standards, the vision of a Joint Mission Environment that enables system testing of Joint requirements is an attainable goal. Also key to a successful JME are the perishable commodities at each of the test facilities. Assets such as personnel, training, system configurations, tools, middleware/protocol versions, etc. must be maintained.

JBD2 was a success, but there are a number of issues and recommendations that need to be addressed by the T&E community. Below is an executive summary list of the major lessons learned/recommendations generated by the JBD2 TIWG.

- Site surveys/certification should be conducted prior to finalizing site lists
- Adequate voice communications are needed in labs (2-3 VoIP & 2 commercial lines)
- All sites should be approved for open storage when conducting a classified test
- Complete list of required IP addresses, Ports and Protocols should be defined early in process
- Sites should have organic/local network support
- Test sites should not have network firewalls if at all possible
- Classified Wiki was very valuable during JBD2 event integration and execution
- Persistent networks, test infrastructure, and continual employee training are needed
- Periodic integration activities with participating organizations is needed to make LVC distributed testing executable in a realistic timeframe and budget

JBD2 JTEM 08 Lessons Learned

Test Integration/Test Management

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13 Jan 09

JBD2 JTEM 08 Lessons Learned
Test Integration/Test Management

OUTLINE

- **Background**
- **OV-1**
- **Sites**
- **Test Design**
- **Lessons Learned**
  - **Site Survey**
  - **Networks**
  - **Communications**
  - **Personnel**
  - **Applications**
  - **Misc**
  - **Spiral Integrations**
  - **Future Recommendations**

JBD2 JTEM 08 Test Event Background and Rationale

Future Combat Systems (FCS)

- Oct 2002: FCS Test (IS&T/CTO) recognized that FCS presents new testing challenges that require new test capabilities
  - Systems of Systems on a grand scale
  - Move, shoot , communicate – simultaneously
  - Seamless integration with Joint elements for Network-centric operations
- 2003 and 2006 TEMP codified the need for investments to provide needed test capability
  - Instrumentation
  - Modeling and Simulation
  - Networking
- Multiple investments initiated to provide needed stimulation, data collection and analysis requirements
- Many of these investments are maturing and need to be tested

DoD Joint Test Capability Roadmap

- **Mar 2003: DoD recognized that it's ability to implement seamless Joint operations is insufficient**
- **2004 DoD Strategic Planning Guidance demanded creation of Joint environment testing capability**
- **2005: OSD Initiated Joint Test and Evaluation Methodology (JTEM) project and Joint Mission Environment Test Capability (JMETC) development effort**
- **JTEM focuses on the methods and processes associated with testing in a Joint environment**
- **JMETC focuses on the infrastructure needed to facilitate the JTEM methods and processes**
- **JTEM and JMETC have created test methods and infrastructure that need to be tested**

2008 Event Objective: Assess suitability of JTEM CTM for testing FCS test technologies using JMETC infrastructure in a relevant Operational context

JBD2 JTEM 08 Test Event Goals

- ***JTEM (Joint Test and Evaluation Methodology)*:** Assess effectiveness and suitability of JTEM Capability Test Methodology (CTM) processes

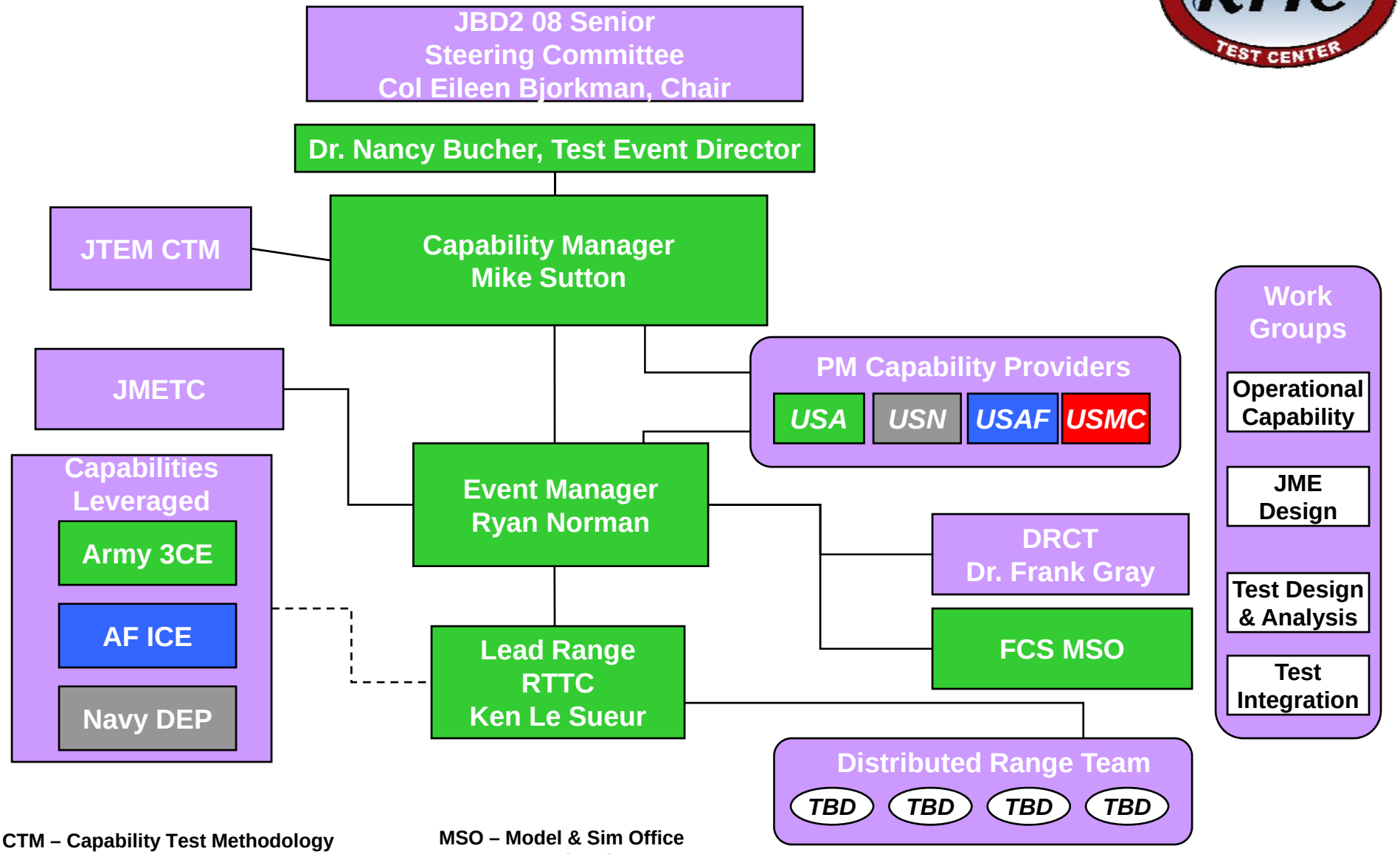
- ***JMETC (Joint Mission Environment Test Capability):*** Characterize the network infrastructure and mature the baseline capability to support SoS level testing across the Services

- ***FCS (Future Combat Systems)*:** Establish a rigorous test context to examine FCS test technology requirements needed for testing in a Joint environment in support of FCS Milestone C test activities
  - Application of JTEM methods and processes; use of JMETC infrastructure
  - Perform test capability assessment within JBD2 context
  - Utilize FCS CTO Test Technology investments to baseline this context
    - Common Control Nodes (CCN)
    - Test Center Assets
    - Test Tools and Instrumentation

- ***FCS*:** Incremental build up of critical FCS test technology areas in a Joint Operational context
  - Network testing support technologies (e.g. Representation of interactions between Joint Platforms)
  - Distributed Test Infrastructure Technologies (e.g. JMETC and InterTEC Technologies)
  - V V & A of the LVC-DE

Support of Joint Initiatives While Addressing FCS Test Technology Objectives

JBD2 Test Event Organization



CTM – Capability Test Methodology
CTO – Combined Test Organization
DRCT – Distributed Range Coordination Team
3CE – Cross Command Collaborative Env

MSO – Model & Sim Office
OTA – Operational Test Agency
PM – Program Manager
JITC – Joint Interoperability Test Center

JTEM Capability Test Methodology (CTM) v1.1

6 Steps
14 JTEM Processes

as of 7/30/07

0. Develop T&E Strategy

- T&E Strategy (TES)
- T&E Master Plan (TEMP)

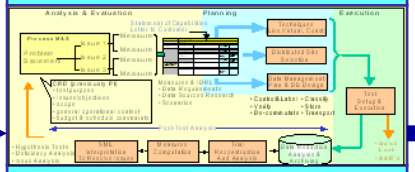
- Develop Capability/SoS Description
- Develop Joint Operational Context for Test (JOC-T)
- Develop Evaluation Strategy Outline
- Develop/Refine Capability Crosswalk

1. Characterize Test

- Program Introduction Document (PID)
- Statement Of Capabilities (SOC)

- Develop Test Concept
- Develop Evaluation Strategy
- Technical Assessment

2. Plan Test



- Develop Test Design
- Perform LVC Distributed Environment Analysis
- Develop Test Plan

3. Implement LVC Distributed Env.

JME Foundation Model (JFM)

- Design LVC Distributed Environment Configuration
- Integrate LVC Distributed Environment

4. Manage Test Execution

5. Evaluate Capability

- Analyze Data
- Evaluate SoS Performance & Joint Mission Effectiveness

Test Concept

Joint Operational Context for Test

Integrated Vignettes LVC Distributed Environment Design

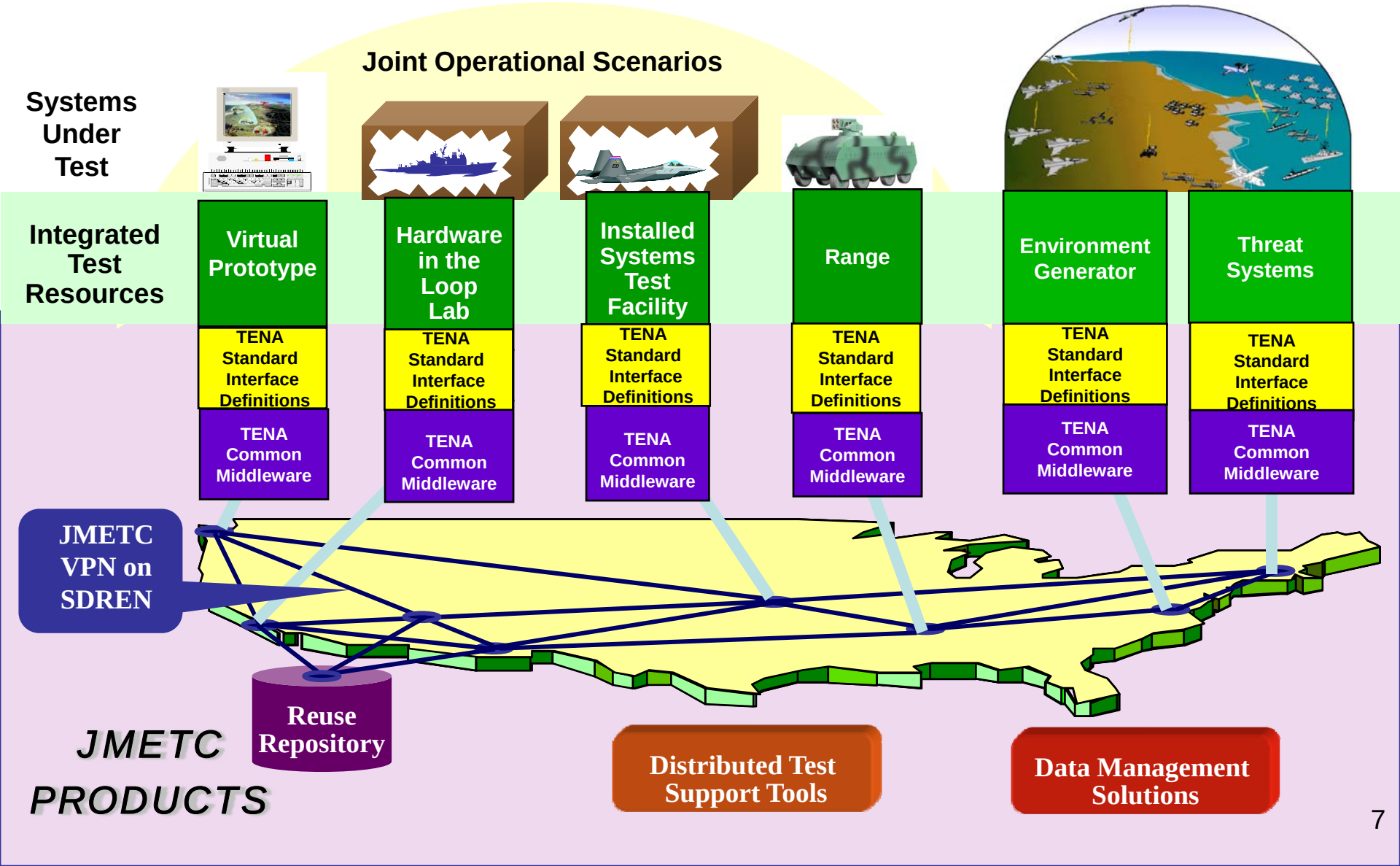
Joint Mission Environment

Test Control & Monitoring

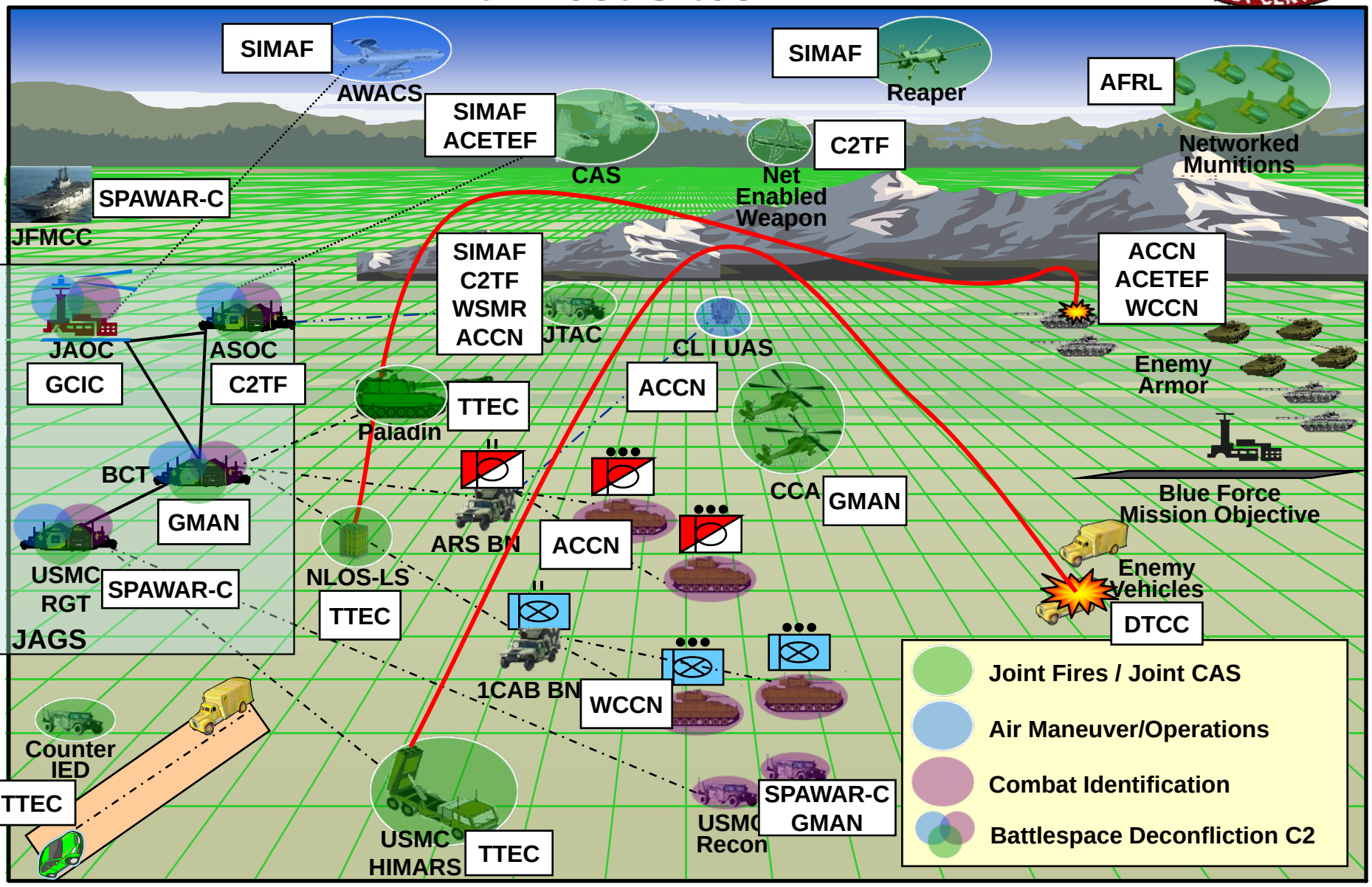
Test Data

LVC – Live, Virtual, Constructive M&P - Methods and Processes
SoS – System of Systems JME – Joint Mission Environment

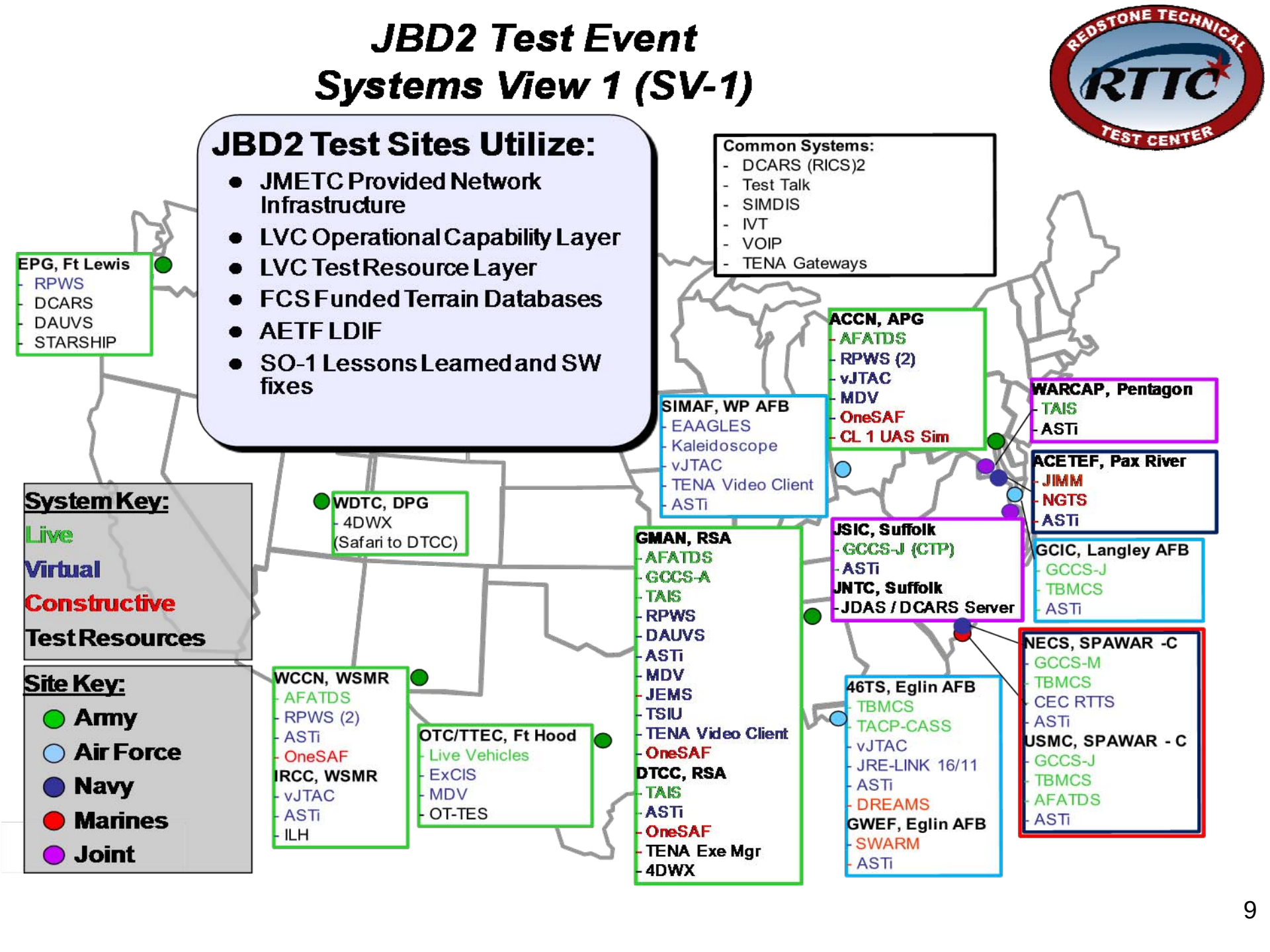
Joint Mission Environment Test Capability (JMETC)



Joint Operational Context for Test (JBD2 JTEM 08 Test Event OV-1) with Test Sites



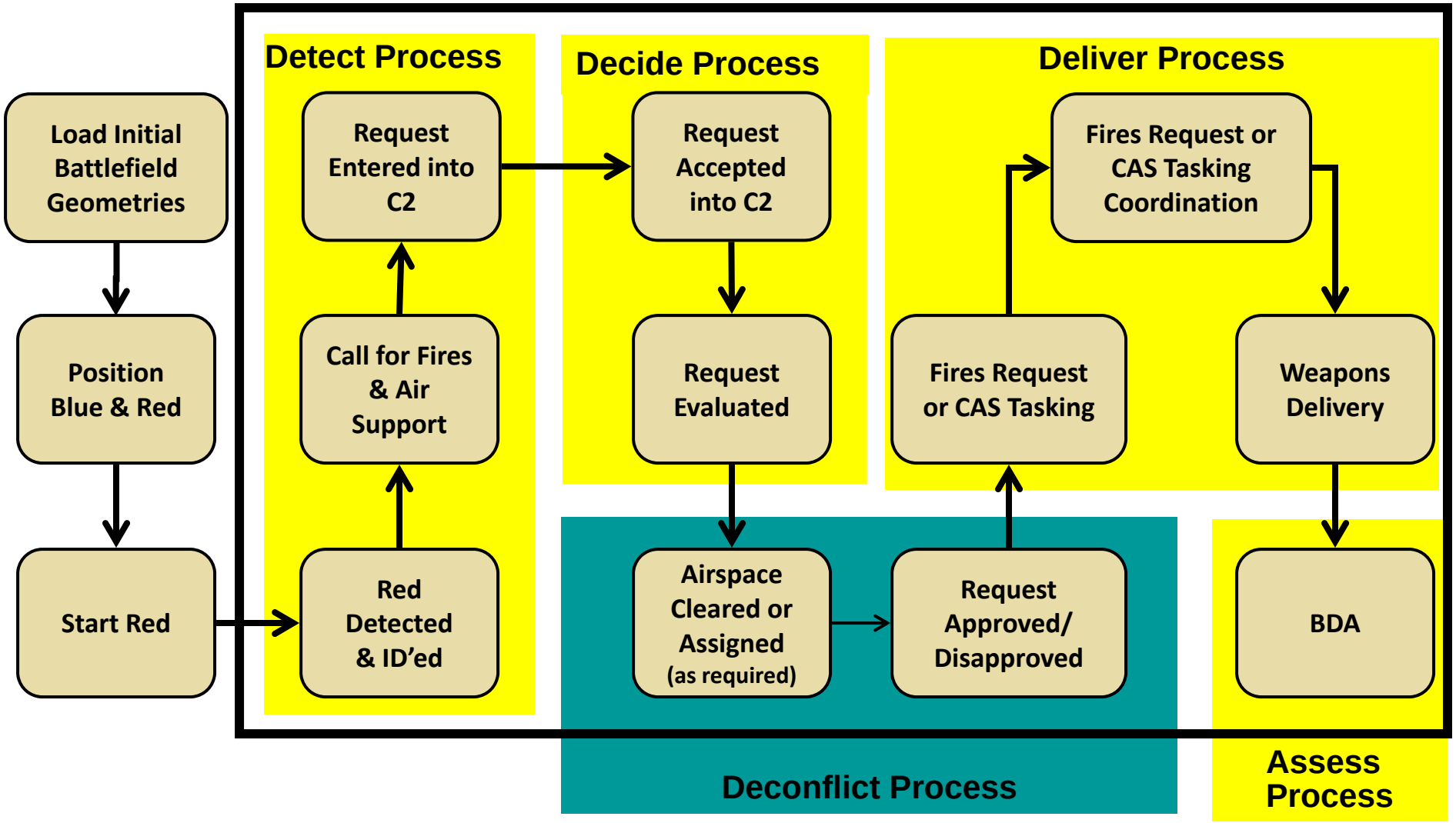
JBD2 Test Event
Systems View 1 (SV-1)



Key Mission Tasks

Type	Mission Task
Joint Fires (JFIRES)	US Army (USA) Maneuver (MVR) Observer to US Marine Corps (USMC) High Mobility Artillery Rocket System (HIMARS)
	US Marine Corps (USMC) Maneuver (MVR) Observer to US Army (USA) Non-Line of Sight - Launch System (NLOS-LS)
	US Air Force (USAF) Unmanned Aerial Sensor (UAS) to US Army (USA) Non-Line of Sight - Launch System (NLOS-LS)
	US Air Force (USAF) Unmanned Aerial Sensor (UAS)/ US Army (USA) Forward Support Element (FSE) to USAF Weaponized UAS (w/SWARM)
Joint Close Air Support (JCAS)	US Air Force (USAF) Joint Terminal Attack Controller (JTAC) to US Air Force (USAF) Fixed Wing
	US Marine Corps (USMC) Joint Terminal Attack Controller (JTAC) to Fixed Wing (US Air Force (USAF) / US Navy (USN))

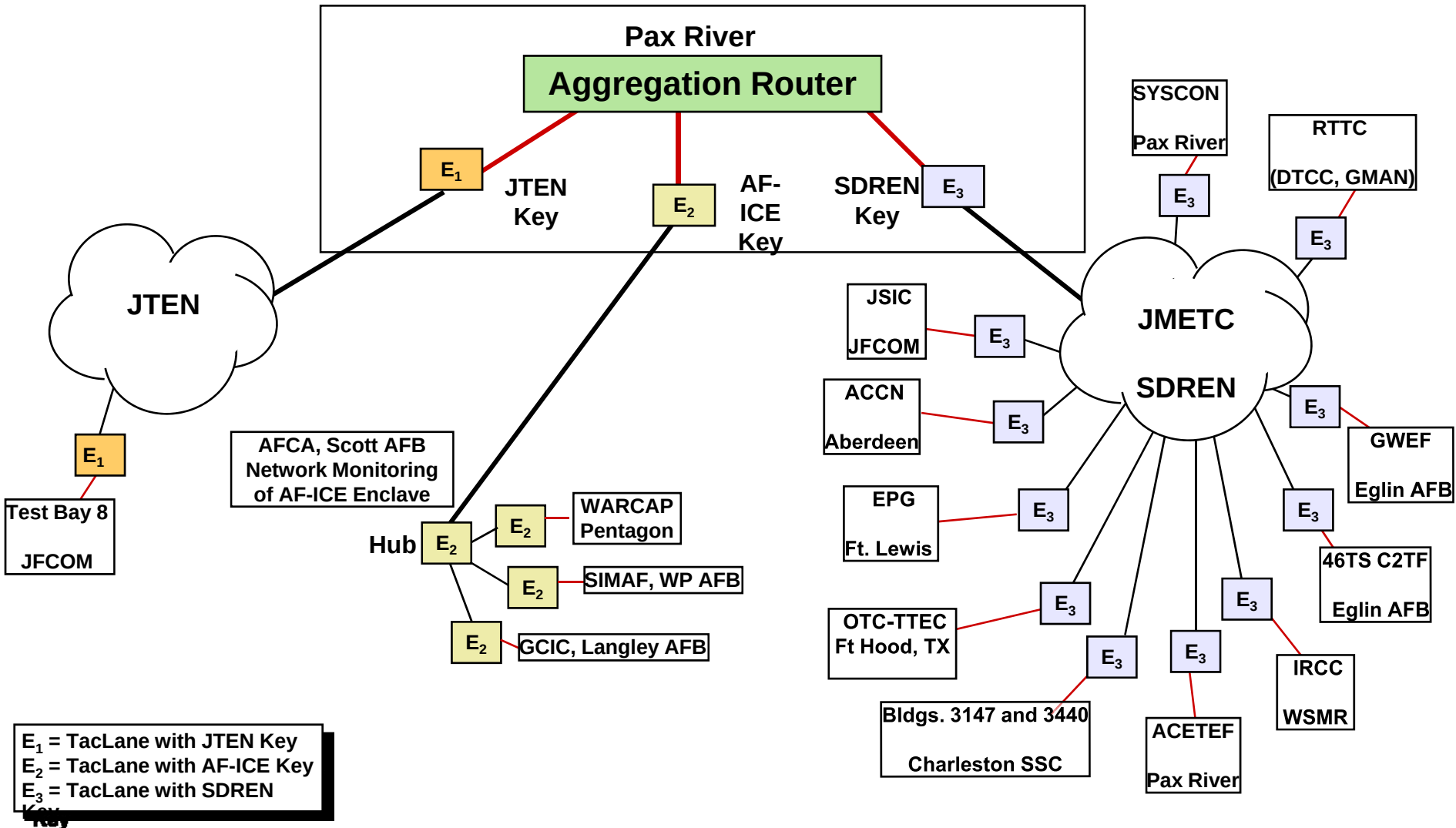
Joint Battlespace Dynamic Deconfliction: Standard Mission Task Flow



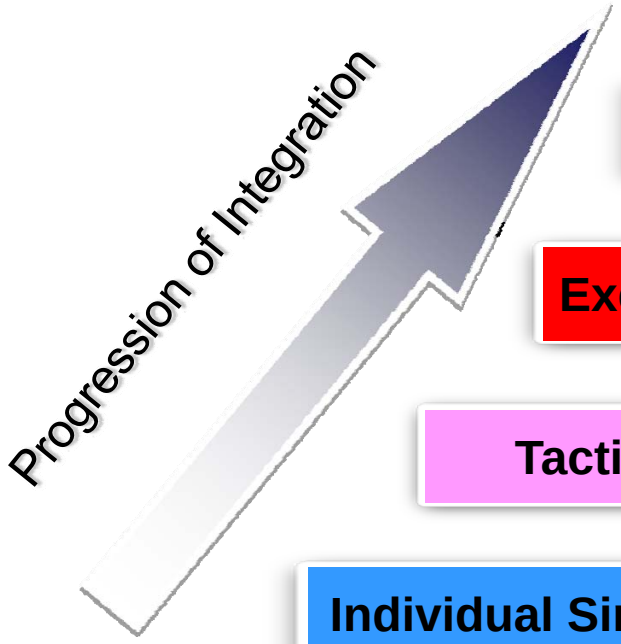
Test Factors and Levels

Trial	Factor 1 Battlespace Management	Factor 2 Timeliness of C2 Processes	Run 1	Run 2
1	Current TAIS 9.3	Current procedural	$[C,C]_1$	$[C,C]_2$
2	Current TAIS 9.3	Future expedited	$[C,F]_1$	$[C,F]_2$
3	Future TAIS 10.0	Current procedural	$[F,C]_1$	$[F,C]_2$
4	Future TAIS 10.0	Future expedited	$[F,F]_1$	$[F,F]_2$

JBD2 Site Connectivity



JBD2 JTEM 08 Integration Plan



- Support of Analysis Activities
- Exe of Service Level “On-Line” Initiatives
- Concurrent Exe of Key Mission Tasks
- Execution of Key Mission Tasks
- Tactical Messaging
- Individual Simulation Exe/Pub/Subscribe
- Test Infrastructure Integration
- Network Connectivity

JBD2 JTEM 08

Lessons Learned

Site Survey

It is recommended that site surveys/certification be conducted prior to selecting which sites will participate in the test. The site surveys should determine if the site:

- can support computers systems running both Linux and Windows OS
- is approved for classified open storage.
- will have adequate personnel available during spiral integration and test runs
- has back-up personnel available for key positions being hosted at that site.
- has enough commercial and VoIP lines available in the lab (2 VoIP and 2 commercial min.). These phones should be located next to key systems.
- has enough computers to run all required applications. Running multiple network-intensive or graphics intensive applications on a single computer should be avoided.

Networking

- IP ADDRESSES, PORT & PROTOCOLS! – few understood the impact to the integration cycles and dry runs caused by IP addresses and ports numbers not being integrated into the firewalls. The majority of all network complaints and issues were related to undocumented ports and IP addresses.
- It is preferred that each lab participating in the test event have organic network support. This allows each lab to quickly react to problems.
  - If a lab does not have organic network support, they should work with their network support organization to have someone on call.
- It is preferable that each lab have access to their TACLANE to perform routine actions such as deleting calls. Where this is not possible, personnel with access to the TACLANE need to be on stand-by.

Networking (Cont.)

- To the extent possible participating sites should not have firewalls. Issues with firewalls consumed a large about of integration time. If firewalls can not be avoided at a site, modifications to the access control list should be made by classes or ranges of IPs, not individual addresses or ports

- Network configuration management and documentation must improve to have a repeatable test process

- Micro TACLANE issue uncovered in JBD2 should be investigated until root cause is determined

Communications

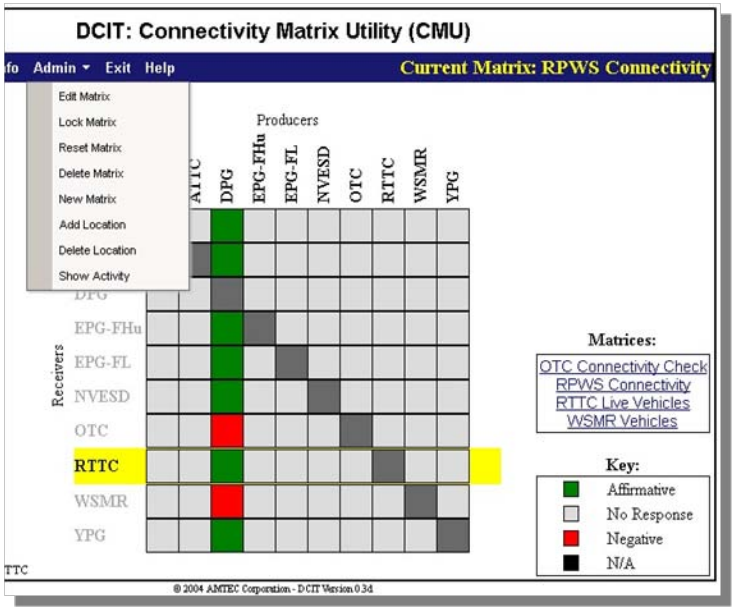
- WSMR persistent phone line was wonderful! Available for whole event.
- All sites need at least 2 and preferably 3 VoIP phones
  - 1 for test control coordination
  - 1 for operation coordination and operational communication backup
  - 1 for back-line trouble shooting
- All sites need at least 2 commercial lines
  - 1 for hotwash & VoIP test control backup
  - 1 for back-line communications
- Ideally phones should be located next to key systems. Some sites reported that the phones were across the room from key systems.
- Sites should have an amplified test control line that can be heard throughout the room. Speaker phones do not work well for this. Some sites prohibit such configurations.
- All personnel talking on the test control line should be on headsets not speaker phones.

Personnel

- Sites should have backup staff for key positions. In a test event lasting several months, staff will be sick or have other obligations.
- During test execution (spirals, dry runs, run for record), one person should be assigned to monitor the test control line.
- More training for test resources and operational systems is required.
- Sites must develop a respect for the rigor of “testing” in LVC distributed environment.

Applications

- New applications or significant changes to applications must be documented, tested, and validated before the integration spirals begin. Some testing can only occur during the spirals, but this should be minimized.
- DCIT is very useful for integrating large distributed events.
- TENA to DIS/MATREX Gateway Comments
  - Can not complete GW development work and testing until application data is submitted. Several applications came in very late.
  - JMETC provided good support from but GW builder developer on site support is needed. Many GW builder code bugs were found during the Integration Spirals.
  - Remote control capabilities should be added to the GW software.



Applications (Cont.)

- DCARS
  - Add capability to collect native AFATDS traffic
  - Add capability to collect ASTi DIS traffic
  - The startup sequence was the same for every run – need automation script
  - Determine path ahead to solve issue with HLA collector feeding RPWS (idea – if buffer fills, throw away out of date data)
  - LAN Data Collector (LDC) stream to DPUs was the largest source of data on network
  - DCARS documentation should be revised to remind installers that DISA Gold should be run after installation of all software on the platform to ensure that the required ports are not blocked.
- Need to incorporate a test conductor chat capability
- We need to understand OneSAF lethality and weapon modeling better
- Test Talk
  - An out of date version of Test Talk was inadvertently use in the test (Lead Range POC error)

Miscellaneous

- Having a classified Wiki was very important for information sharing after the concept was embraced by all sites.
- Daily situation reports (SITREPS) provided to a large audience are very valuable. Need public and private views.
- Time Ordered Event List (TOEL) for Pre-Start configuration proved very beneficial in starting the complicated environment in a structured, repeatable manner
- Having a procedure for data transfer across security domains would expedite the SITREPS and reporting process.

Spiral Integration Activities

- Multiple spirals are required to integrate a large multi-site test event.
- Complicated operational scenarios with complex tactical communications require more spirals. Several spirals need to be devoted to working operational issues. These can not be performed until the technical integration is complete.
- If technical personnel are required to play an operational role or use operational equipment, at least one spiral needs to be devoted to this training.
- Full integration testing can not begin until all sites are online.
- It is possible to perform multiple activities simultaneously during a spiral. To be effect sites need multiple staff and communication lines to participate in simultaneous activities. Each simultaneous activity needs a lead.
- The lead range should support one-on-one testing as needed during early integration to help with application testing.

Future Recommendations

- Persistent networks, test infrastructure, and continual employee training are needed along with periodic integration activities with other organizations to make LVC distributed testing executable in a realistic timeframe and budget.
- Test control and Network Characterization tools should have remote operation capabilities
- A real-time TENA capable Cross Domain Solution will allow visualizing tests and performing some data analysis in an unclassified environment.
- Consider classified VTC capabilities in the lab to aid in communications. This was used between DTCC and GMAN labs in JBD2 and worked well.
- A “Test Harness” class of tool would aid sites in certifying the ability to exchange data properly before entering integration.
- Determine proper method for Joint testing Security Classification Guide development.

Future Recommendations (Cont.)

- Develop network design approach that will handle the tactical IP space (non-routable addresses).
- Integrate a Cross Domain Solution (CDS) for the classified and unclassified Wiki
- Use tactical network and voice communication simulations Vs. “perfect” connections.
- Consider performing on-site integration for selected sites.
- Service Information Assurance (IA) requirements for all applications should be consistent
- Should have a backup plan for all critical applications and sites – will increase integration activities and cost.

Questions?